

Remarks

Reconsideration is respectfully requested.

Claims 1-2 are canceled. Claims 3 and 5-10 are pending in this application. Claims 9 and 10 are newly added. Claim 3 has been amended to insert a hyphen into "non-orthogonal" and to make clear that the recovery matrix reverses the scrambling operation that was performed by the transmission matrix by descrambling. Applicant has amended claims 5 and 8 per the Examiner's Objection. Claim 5 has also been amended to replace the word "redundant" with "corrupt" and to change the word "terms" to "symbols". Claim 6 has been amended to change the word "in" to "on" and to make clear that the recovery matrix reverses the scrambling operation that was performed by the transmission matrix. Claim 8 has newly added claims 9 and 10 deal with the cases where the number of corrupt symbols dropped necessitates the use of a square inverse recovery matrix instead of a rectangular pseudo-inverse matrix.

In brief, the claims relate to a system and method for signal transmission comprised of a input symbol sequence, a two-dimensional over-determined transmission matrix that creates a transmit symbol sequence that contains more transmit symbols than were in the input symbol sequence. The additional (excess) transmit symbols are redundant symbols. Corrupt symbols in the received symbol sequence may be discarded, provided that the number of columns is still greater than or equal to the number of rows. A recovery matrix is formed by computing a pseudo-inverse of a transmission matrix that has been modified by dropping columns corresponding to corrupted symbols in the received symbol sequence. If the number of corrupt symbols is greater than the number of rows, the system of equations has more unknowns than equations, and cannot be solved.

The present transmission system creates a system of M equations with N unknowns, where M (the number of columns) is greater than N (the number of rows). That is, given the number of unknowns, there are more equations available than are required to find a solution. If some of the symbols are corrupted by transmission impairments, the set of equations can still be solved if M is still greater than, or equal to N. The method works because the system of equations is non-orthogonal, and a solution can be found using a pseudo-inverse matrix. If some of the symbols are corrupted, a new pseudo-inverse matrix is created to find a solution with the available

non-corrupt symbols. For the case when so many symbols have been dropped that M=N and the matrix is square, an inverse matrix is used.

Prior-art orthogonal sets of equations can be solved with a simple transposed square matrix.

Conventional prior art solutions to the problem of corrupt symbols typically use forward error correcting (FEC) codes on the recovered data, typically linear block codes or convolutional codes.

Claim Objections

Claim 5 was objected to because of a possible antecedent basis problem. The Examiner's suggested correction is incorporated.

Claim 8 was objected to because of an 's' in the claims. The Examiner's suggested correction is incorporated and the 's' has been replaced with an 'a'.

Claim Rejections – 35 USC 103

In general, the prior art did not recognize the source of the problem addressed by the invention. The present application provides three motivations for using matrices comprised of non-orthogonal basis functions:

1. Scrambling to foil unintended listeners. As stated on page 3 of the application, lines 7 to 15, one of the objectives of the application is to build a system that would be difficult or impossible for an unintended listener to decode.
2. Gaining an ability to excise corrupt symbols in the time domain. As stated on page 3 of the application, lines 7 to 15, another objective of the application is to build a system that is tolerant of frequency selective fades or bursts of impulsive noise.
3. Gaining an ability to excise corrupt symbols in the frequency domain.

None of the cited prior-art references achieve any of these three advantages.

Kuchi (US 7,006,579) describes in its abstract a system that uses non-orthogonal basis functions. The applicant respectfully disagrees, and believes that the Kuchi matrix is, in fact,

comprised of orthogonal basis functions. A Kuchi states that the matrix is non-orthogonal because it is comprised of two summed orthogonal matrices in column 4 lines 22 - 27. To fix the problem of being unable to resolve two symbols transmitted on top of each other in the same time slot, Kuchi makes a "complex diversity transform" as described in column 6, line 46 to column 7 line 6. The "complex diversity transform" simply raises the number of points in the constellation, increasing the number of bits per symbols at the expense of reduced immunity to random noise. This constellation makes the Kuchi system orthogonal, like to the Alamouti system (US 6,185,258), which also uses orthogonal basis functions. Kuchi also discloses in column 5 lines 50-57 that a transmission is received by prior art methods described by Alamouti, and Alamouti's receiver only works with orthogonal basis functions.

Furthermore, were the Kuchi matrix non-orthogonal, it could not be recovered, because an inverse matrix cannot be computed. As stated earlier, the Kuchi matrix is comprised of elements that are mathematical operations, such as complex conjugation, so an inverse is impossible to compute. Fixed elements are needed to compute an inverse.

The combination of references renders the constructions of the references inoperable for their intended use. None of the prior art teaches using an inverse matrix to receive a signal that was created by a matrix multiplication at the transmitter. An inverse recovery matrix that canceled the effects of channel distortion, such as presented in US 5,450,445 (Ushirokawa) could not descramble a signal that was intentionally scrambled at the transmitter. Thus, the present invention utilizing a recovery matrix that did not descramble a scrambled signal would be inoperable. Likewise, a recovery matrix that canceled multi-path distortion on a MIMO (multiple input, multiple output) antenna system, such as US 7,242,720 (Sugiyama) also would not able to perform the necessary de-scrambling of a signal intentionally scrambled at the transmit site, as is required by the present application.

Claim 3.

The Examiner is respectfully requested to distinctly point out where the use of pseudo-inverse of the transmission matrix, as stated on Final office action page 4, lines 4-8 is known in the art. Further, the Examiner is requested to point out where in the prior art there is motivation to combine a received scrambled symbol sequence and a pseudo-inverse de-scrambling matrix to achieve the claimed invention.

No cited prior-art reference combines the transmission of a symbol sequence created with an over-determined matrix comprised of rows that are non-orthogonal basis functions.

Furthermore, no prior-art reference teaches the recovery of the transmitted symbol sequence using a pseudo-inverse matrix. The prior art taught away from the proposed combination. It would be illogical to use a transmission matrix with non-orthogonal basis functions because:

- A. Increased inter-symbol interference would occur in the presence of random noise, and
- B. A much greater computational load would be placed upon the receiver. That is, it is much harder to perform a full matrix multiply (as is required with an inverse matrix) than to perform simple cross-correlations to recover symbols (as is possible with orthogonal basis functions). Furthermore, computing the pseudo-inverse and inverse matrices is computationally difficult.

Therefore, the combination of references renders the constructions of the references inoperable for their intended use. The recovery matrix must be a descrambling matrix that reverses intentional scrambling done by the transmit matrix. The prior art transmit matrices do not employ scrambling and prior art recovery matrices could therefore not perform the required descrambling.

Claim 5.

The Examiner is respectfully requested to distinctly point out where creating a pseudo-inverse matrix based on corrupted signals is known in the art. Further, the Examiner is requested to point out where in the prior art there is motivation to combine dropping corrupt symbols and using a modified pseudo-inverse recovery matrix to achieve the claimed invention.

The proposed combination would not have been expected to be successful by those skilled in the art. As stated on page 3 of the application, lines 7 to 15, another objective of the application is to build a system that is tolerant of frequency selective fades or bursts of impulsive noise. None of the prior art references taught a method of dropping corrupt frequency domain or time domain symbols and creating a modified recovery matrix that is determined by which corrupt symbols were dropped.

Claim 6.

The Examiner is respectfully requested to distinctly point out where creating a transmit symbol sequence by scrambling an input symbol sequence by a transmission matrix and then performing an IFFT on the result is known in the art. Further, the Examiner is requested to point out where in the prior art there is motivation to combine a scrambled transmit symbol sequence with an IFFT operation to achieve the claimed invention.

Claim 8

The Examiner is respectfully requested to distinctly point out where removing corrupt symbols and creating a custom pseudo-inverse recovery matrix is known in the art. Further, the Examiner is requested to point out where in the prior art there is motivation to combine removing corrupt symbols and making a custom pseudo-inverse matrix to achieve the claimed invention.

There was no motivation or suggestion in the art that would have prompted one skilled in the art to make the combination. None of the prior art references taught a method for performing an inverse fast Fourier transform on what is essentially an already-transformed (scrambled) signal. There would be no motivation to go through this extra computational step, which allows the receiver to remove corrupt signals caught in a deep frequency selective fade.

The absence of additional patentability arguments should not be construed as either a disclaimer of such arguments or that such arguments are not believed to be meritorious.

Applicant believes no new material has been added.

Applicant believes the application to be in condition for allowance, and such action is earnestly requested.

Dated this 4th day of Jan, 2008

Respectfully submitted:

Thomas H. Williams

Thomas H Williams

6423 Fairways Dr.
Longmont, CO 80503
303-449-9070
303-444-6140 (fax)

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, PO box 1450, on January 4, 2008.

Thomas H Williams

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